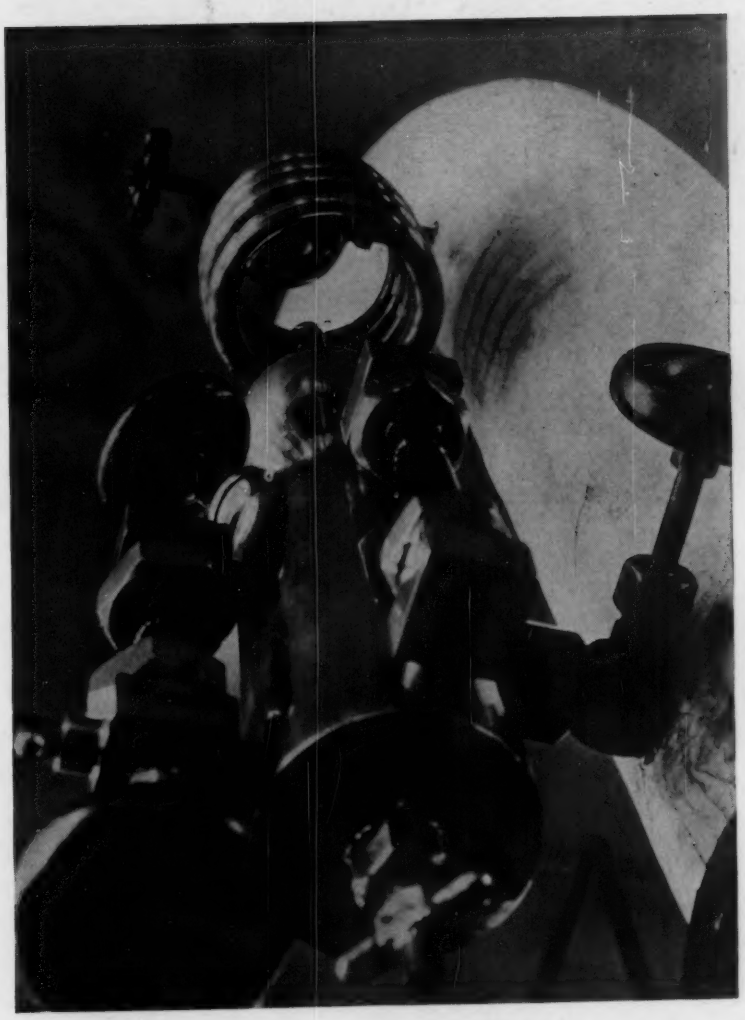
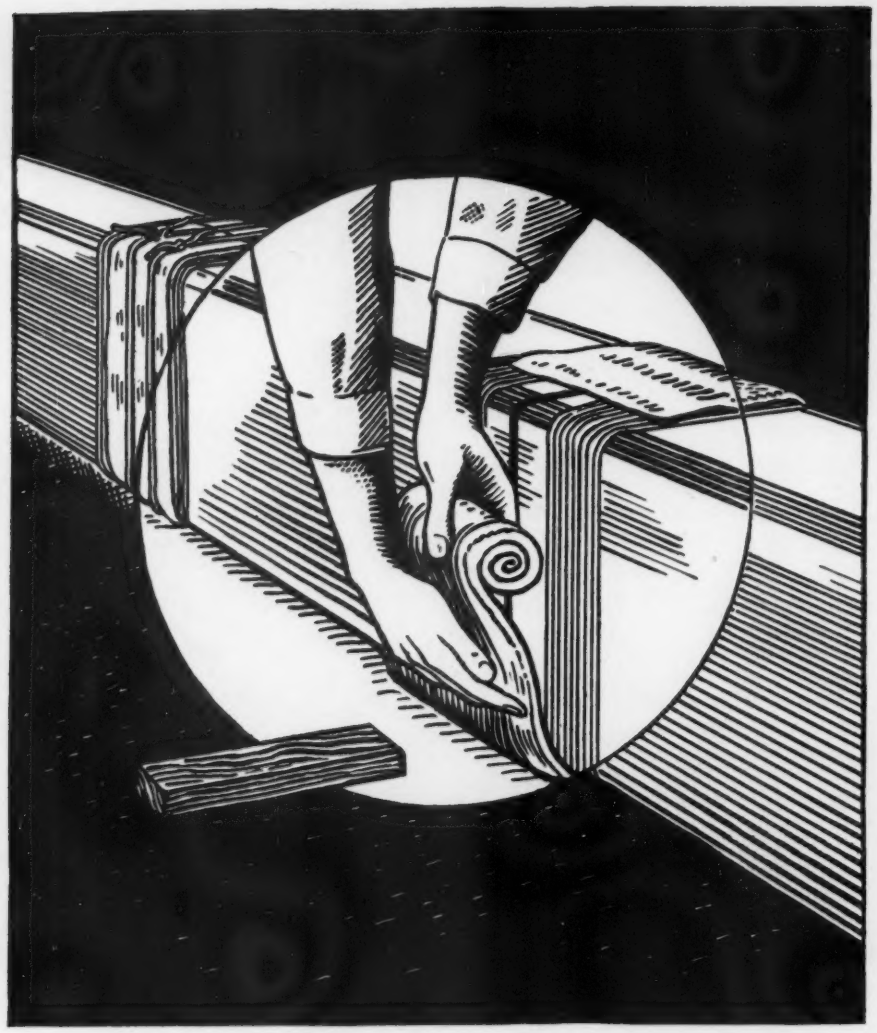
THE TECH ENGINEERING NEWS



JANUARY, 1933 VOLUME XIII, NO. 8
MASSACHUSETTS INSTITUTE OF TECHNOLOGY



FIRST AID
for *unbroken* joints

How to keep silt and sand from clogging telephone cable ducts was one problem put up to engineers at Bell Telephone Laboratories. No known method of joining sections of vitrified clay conduit effected a seepage-tight joint.

With scientific thoroughness, telephone men made many tests under service conditions. They devised a bandage of cheese-cloth, waterproof paper and mortar. Easily made and applied, this mortar bandage is tight against silt and sand. It prevents clogging, greatly simplifies the installation of new telephone cables and the removal of old ones.

Through solving such interesting problems, Bell System men work steadily nearer to their goal —telephone service of highest possible efficiency.

BELL SYSTEM

A NATION-WIDE SYSTEM OF INTER-CONNECTING TELEPHONES

The TECH ENGINEERING NEWS

Volume XIII CAMBRIDGE, MASS., JANUARY, 1933 Number 8

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CONTENTS

THE COVER: GUIDE FOR STEAM
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MEN *v.* STEEL . . . . . *Frontispiece*

THE OUTLOOK FOR THE 1933 SENIOR 143
By Frank L. Locke

A LABORATORY FOR PRACTICAL ELECTRONICS . . . 144
By Truman S. Gray

SOCIETY — A PROBLEM IN THERMODYNAMICS . . . 146
By Harold Ward

THE SUN — AN ENGINEERING MASTERPIECE . . . 148
By Donald H. Menzel

HELPING INDUSTRY TO BUILD ITSELF 150
By Leonard H. Church

THE MANUFACTURE OF PRINTING INK AND ITS CHARACTERISTICS 151
By Carl E. Foss
With illustrations in full color

ENGINEERING DIGEST 155

EDITORIALS 156

THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

Chairman, ROBLEY WINFREY
Iowa State College, Ames, Iowa

Auburn Engineer
Colorado Engineer
Cornell Civil Engineer
Illinois Technograph
Iowa Engineer
Iowa Transit
Kansas Engineer
Kansas State Engineer
Marquette Engineer
Michigan Technic
Minnesota Techno-Log
Nebraska Blue Print
Ohio State Engineer
Oregon State Technical Record
Penn State Engineer
Pennsylvania Triangle
Purdue Engineer
Rose Technic
Sibley Journal of Engineering
Tennessee Engineer
The Tech Engineering News
Wisconsin Engineer

MEN
V.
STEEL

Metal Progress

THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME XIII JANUARY, 1933 NUMBER 8

THE OUTLOOK FOR THE 1933 SENIOR

By FRANK L. LOCKE

Personnel Director, Massachusetts Institute of Technology

THIS year the college graduate will face a cold, calculating buyer's market. Already the thoughtful senior is asking himself:

Will there be any jobs open when I finish school in June?

What sort of job am I fitted for?

What have I to offer a prospective employer?

What qualifications does an employer particularly look for in an applicant?

What sort of job do I want?

If I am unable to secure just the job I want, what is my second choice?

How can I make the contacts necessary to locate possible openings?

What is the best method of applying for a position?

Should I write letters to prospective employers?

Are personal calls more effective?

How can I most effectively outline my qualifications, both in writing and in a personal interview?

Some seniors, through family connections, summer employment, or the interest of friends, are already assured of places. These men are indeed fortunate. Those not thus fortunately provided for will do well to give early thought to the problem of placement.

Careful consideration of the foregoing questions will prove not only helpful in solving the placement problem, but valuable in focusing attention on the development of personality — nowadays recognized as a most important factor in business and industrial organizations. It is the policy of the Institute to impress upon graduates their own responsibility for securing positions. Heads of departments and members of the staff, however, have a keen interest in the successful placement of graduates in positions for which they are best fitted, and are always ready to supplement the graduate's own efforts with advice and every possible assistance.

What are the requirements of the employer in considering the senior for possible association in his business? Of course he expects scholarship, and generally the Technology degree is sufficient guarantee in this connection, though in some instances the call is for men only in the upper half or upper third of the class. For highly technical and research work, often only men of outstanding scholarship will be considered. Almost uniformly the first and special inquiry is for high character and integrity. Loyalty and industry are stressed. Good appearance and pleasing manners are carefully considered. Mental alertness, the ability to think a problem through from beginning to end, logically, clearly, and concisely, is important. Perseverance, cheerfulness, and good temper, are subjects of active inquiry. The ability to work for and with others and the faculty to direct successfully the work of subordinates, are likewise given careful attention. Keenness of observation and the power of expression are sought and highly rated. As bearing particularly on coöperativeness and leadership, employers are interested to know of a candidate's participation in extra-curricular activities. The character of any undergraduate employment and the extent to which a student has paid his way through college are items of interest.

Typical of the attitude of the employer is the following statement of a high business executive:

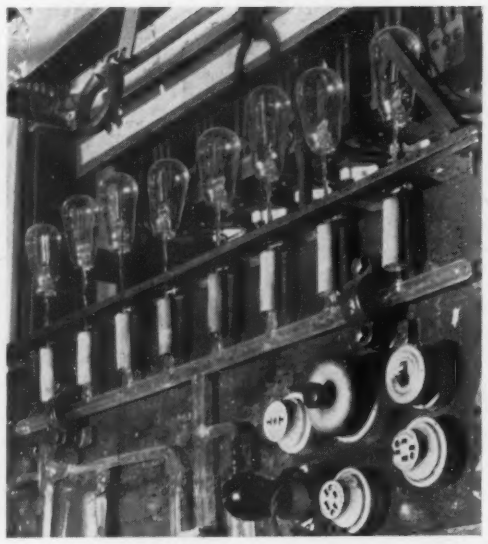
(Continued on page 158)

Advertising and Selling. The Employers' Group

A Laboratory For Practical Electronics

By DR. TRUMAN S. GRAY
Instructor in Charge,
Engineering Electronics Laboratory

THE last quarter century has been marked by a rapid increase in the development and application of the so-called "electronic" devices. In them an electron current is conducted through a vacuum or a gas, due wholly or in part to the motion of electrons. This field has been and is now an outstanding frontier for vigorous and concentrated activity toward the betterment of our facilities for the communication of intelligence, the control of forces, and the indication of the behavior of the tools we use. This endeavor provides a continually changing insight into the possible results of engineering development in the future.



The Exhaust Process. A vacuum pump, a gas-heated oven (above), and an induction furnace are used to remove the gas from the tube. The tube is then closed by sealing off the stem and mounted in a standard base.

At present, probably the most striking example of this growth is the extension of the methods of communication of intelligence. Long distance telephone transmission, radio transmission, and radio reception are all in advanced stage of development. They all depend upon electronic phenomena in the vacuum tube. Moreover, many other applications are being made which, while not so apparent to the eyes of the average person, nevertheless have a direct bearing upon his everyday activities. Among them are the control of elevator levelling and door action, the control of illumination in school rooms and auditoriums, the control of smoke nuisance from chimneys, the sorting of cigars and mail bags, the ringing of burglar alarms, traffic control, and literally hundreds of other applications actually close to the "man in the street". At the same time there are many more remote, but just as useful, developments involved in the manufacture of articles such as the control of the ingot as it passes through the rolls of a steel mill and the control of the speed of the rolls in a paper mill. Of equal importance, but still further behind the scenes, are the uses of electronic devices as the tools of the laboratory. Not only are they useful in the electrical laboratory where they are used to measure small currents and voltages, or to furnish alternating current of high frequency, but also in other lines as well, such as in the measurement of thickness or the investigation for flaws in a steel wire. These few instances serve to illustrate the manner in which the vacuum tube and its brothers have become indispensable in a large and varied number of places.

These developments have not been the product of any one individual or group of individuals. They are a striking result of the combined efforts of many groups, in particular the physicists and the engineers. The problems of the engineer have provided the incentive by the physicist, whose discoveries have in turn made possible new applications and the uncovering of new problems by the engineer. Although there is inherently a considerable degree of overlap between the two fields, in general, the physicist has been endeavoring to discover the nature of the fundamental processes occurring in electronic apparatus and a better means of predicting their performance. The engineer, on the other hand, has been concerned with the problem of finding economical means of producing and applying new apparatus to perform useful service. There is thus a need in industry for trained men of both types, a need which has increased rapidly within the last few years. This need can best be fulfilled by men from educational institutions.

The educational facilities available for training in physics have kept pace with the electronic developments, and today the subjects of thermionics, photo-electric effect, ionization in gases, conditions in an arc stream, all of which are of fundamental importance, are adequately taught in leading institutions. Several years ago there was introduced into many of the engineering curricula separate courses on the subject of communications. In this particular field, a study is made of the engineering application of vacuum tubes to that particular purpose. But the subject of engineering electronics has grown until it has ceased to be a specialized one in a single field. It is now important, and is becoming increasingly so, as a part of the basic training of all electrical engineers.

Recognition of this fact recently led to the installation of the Engineering Electronics Laboratory at the Institute. Laboratory instruction has long been recognized in this country as a vital element in any effective pedagogical scheme of engineering education. In the textbook or classroom treatment of most engineering problems, there are always introduced assumed ideal conditions in order to bring the problem within the range of our mathematical ability. To accept the solution thus obtained as true of the actual performance of the device is to neglect many secondary but important factors which may modify its behavior to a considerable degree. Laboratory work is of primary importance in bringing together all the phenomena and disclosing them in their proper relationship. Particularly is this true of the electronics' field in which the phenomena are exceedingly varied and complex.

The situation here is quite analogous to that of the infant subject of electrical engineering fifty years ago. Laboratory methods at that time were the backbone of the educational curriculum. Investigatory methods

involving new combinations of machinery brought out many puzzling and interesting problems which required the building of new machinery not available as commercial equipment. Such machinery was often built in the laboratory. The stimulus to the student's initiative, originality, and self-reliance of the procedure of following through to the final application the complete construction and study of a new device was of great value. This exemplary method serves as a basic pattern for the plan of the Engineering Electronics Laboratory. In it, facilities for similar work in that field have been provided.

It is a significant fact that a majority of electronic devices of engineering importance can be assembled by means of equipment used in radio-receiving tube manufacture. Such equipment forms the nucleus of the laboratory equipment. Since there are many repetitive processes not easily performed by the unskilled, such as the enclosure of the tube parts in a glass bulb and subsequent evacuation, automatic machines are provided to perform these operations. Making the press or stem through which the wires are led, sealing the bulb around the parts, and attaching a standard base are all automatically performed. Freedom from the necessity of spending time in development of skill in glass working is afforded the students by these machines, and the whole of his efforts may be concentrated on the assembly of the metal parts and the evacuation processes. Electric spot welders provide a rapid method for assembling the elements.

Three vacuum systems are available for the exhaust of tubes: one for tubes containing a high vacuum, a second for tubes containing mercury vapor, and a third for tubes containing a gas. These pump systems are constructed to have a high degree of speed and flexibility in the exhaust process. One is of a type used by radio tube manufacturers immediately preceding the introduction of the modern high-speed automatic exhaust machines.

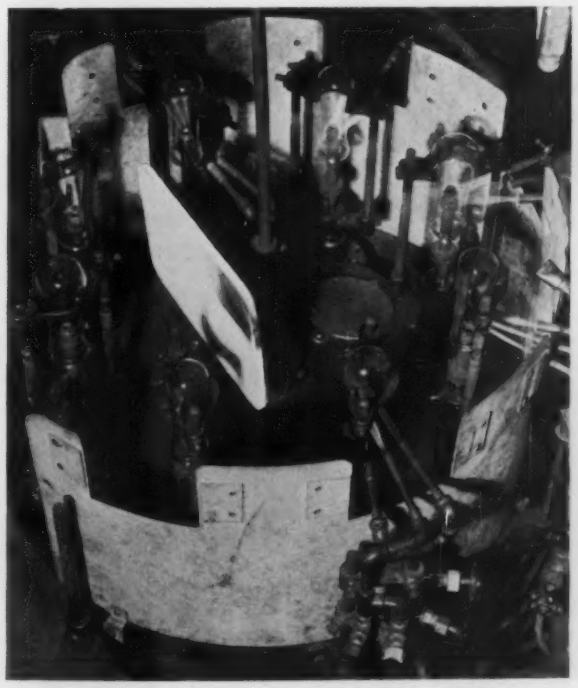
Two operations are necessary to the production and maintenance of a good vacuum. They are the removal of gas from the glass walls and from the metal parts. Means for performing these operations are provided for by ovens which can be lowered around the tubes and a powerful high-frequency generator with a coil which can be placed around the tube to heat the metal by induction. Although much of the equipment is of a specialized nature, it is readily adaptable to a great many needs for which it was not designed.

With this equipment it is possible to build rapidly, with a minimum of time spent in repetitive or difficult operations, electronic devices of almost endless variety involving all of the important processes now known and used in this field. A few of the better-known types of apparatus which have been constructed in the laboratory are the rectifier, three-element vacuum tube, multi-element tube, photo-electric cell or "electric eye," gas-filled or mercury-vapor lamps and rectifiers, and the controlled arc rectifier, better known as the thyratron, or grid-glow tube. In addition to undergraduate instruction, the laboratory fulfills a useful function as an aid to research in the production of special devices and the performance of special processes needed in investigatory work throughout the Institute.

The results are well exemplified by the enthusiasm of the students. They indicate that the laboratory has been successful in stimulating and developing their initiative, spirit of inquiry, and resourcefulness. It has been found possible for a number of them to build, without previous experience, a simple vacuum tube in a single laboratory period of three hours. This training, with subsequent electrical testing, gives a grasp not only of the electrical performance, but also of the measures necessary to obtain that performance. Comparison with the results of others on ostensibly similar tubes often shows appreciable differences which are the result of uncontrolled factors, and thus serves to illustrate the importance of these factors in modifying the theoretical behavior of the apparatus.

An example of the completeness with which the new laboratory can cover the electronics field is contained in the following train of devices, all of which have actually been constructed in the laboratory. An electric light bulb (constructed in the laboratory) supplies light which falls on a photoelectric cell. The light causes a feeble current to flow through the cell, which current actuates a thyratron or grid-glow tube. This latter tube enormously amplifies the feeble photo-cell current, so that it can operate an ordinary relay. The relay in turn operates a neon-tube sign which glows in the well-known manner of neon signs. Every device in this electric train of events, with the exception of the relay (which is not an electronic device) has been successfully constructed and used by students.

The Engineering Electronics Laboratory, the only one of its kind in an educational institution, was originally planned for the purpose of "emphasizing the fundamental, physical, chemical, mathematical, and economic relationships which govern the design, construction, and use of apparatus of this type." In addition to undergraduate instruction, the laboratory fulfills a useful function as an aid to the allied research in the construction of new types of apparatus and to the performance of special processes needed in investigatory work throughout the Institute. Its effective use during the past year by both students and staff members marks the new laboratory as a valuable asset to the facilities of the Institute.



Sealing-In Machine. The glass bulb with metal parts supported on a stem inside it is revolved in each of the flames successively until it is fused to the stem, thus forming a vacuum-tight container.

Society: A Problem in Thermodynamics

*An authorized statement of the organization and aims of Technocracy**

By *HAROLD WARD*

ENERGY is in the saddle and rides mankind." This paraphrase of Ralph Waldo Emerson's celebrated dictum not only gives away the real secret of all past civilizations, but also directs attention to the sole criterion by which present and future civilizations are correctly to be appraised. Human societies, insofar as they are operating mechanisms, are not a function of human "values" — as is assumed in all social theory from Plato to and including Karl Marx — they are expressions of impersonal material factors susceptible to exact quantitative measurement. And basic to all these factors is Energy: not the quasi-mystical concept of an Ostwald or any philosophic equivalent, but the physicist's downright and exceedingly prosaic "capacity for doing work."

It has been left to the quiet and persistent labors of a group of American technologists, engineers and scientists, working under the name Technocracy, to inaugurate what can only be described as a Copernican revolution in all the so-called "social sciences." Under the direction of Howard Scott, one of the original founders and himself an engineer of broad experience and recently in association with Dr. Walter Rautenstrauch's Department of Industrial Engineering at Columbia University, and the Architects' Emergency Relief, this twelve-year-old research body has been conducting an "Energy Survey of North America." From the material already released to the press and widely commented upon both here and abroad, it has become clear that, if we are really to understand the nature and operation of a modern industrial social complex, an ounce of Thermodynamics will serve us better than a ton of whatever political, philosophic, cultural or economic nostrum we choose to name.

The following brief résumé of the work of Technocracy should have a particular significance for readers of THE TECH ENGINEERING NEWS, who by training, if not always by temperament, are habituated to the scientific ideal of Precision.

From the dawn of recorded history until the eighteenth century all the work of human societies was done directly by, or in close association with, the human engine. Each adult unit of this biological prime mover had a work capacity averaging one-tenth of a horsepower on an 8-hour day basis; equivalent, in rate of doing work, to 1,500,000 foot-pounds, or an energy consumption doubtfully exceeding 2,000 kilogram calories per capita per day — or approximately 8,000 British thermal units. In other words, one human being, laboring for eight hours, with an overall mechanical efficiency not much greater than 30 per cent, expended energy equivalent to the burning of 12 ounces of medium grade bituminous coal. Under such severe restrictions — precariously supplemented by the institution of slavery — ancient empires had their dawn, ascended, crossed their meridians of triumph, and declined, yielding to others of the same *physical* order of magnitude, however different in customs, government and culture. For seven thousand years human societies were operated at an "energy conversion rate" limited by the capacity of the human engine, plus domestic animals and a few primitive mechanical appliances. Man himself being the principal machine, there were developed — and are today strenuously maintained — systems of government and economic theories predicated upon the *functional* supremacy of "human nature" rather than upon that of physical laws. The entire structure of individualist philosophy, in whatever domain of thought or action, still rests upon the assumption that Man, with his limited energy and illimitable desires, is the unique arbiter, and final determinant, of social destiny.

But in the year 1712 that assumption was for the first time seriously challenged by the original Newcomen engine. Installed to pump water from an English colliery, it performed work at a rate of 5½ h.p., thus replacing 55 human engines. In 1780 the rate was increased to 50 h.p. Cumbersome and inefficient as it was, this dinosaur of the approaching Technological Epoch required only three men to accomplish the work of five hundred.

For Americans "1776" means the Declaration of Independence, but it marks also two other significant

*With the past few months, public interest has been turned toward a group of research engineers who call themselves Technocracy. Their work, and their reasons for doing it, have been subjects of great interest both here and abroad. We are glad to present, therefore, this article which describes what Technocracy is, what it is trying to do, and a few of the things it has already accomplished. The manuscript has been read by Howard Scott, Director of Technocracy, and is published with his approval. — THE EDITOR.

events: in that year appeared Adam Smith's "Wealth of Nations" and — the irony is perfect — Watt's first successful steam engine, installed in John Wilkinson's iron works in England. By 1800 the pioneer industrial firm of Boulton and Watt had erected 289 steam engines in England alone, and at Philadelphia in 1876 the improved Watt engine had reached its peak in the Corliss reciprocating engine, which delivered 7,800 h.p., equivalent on a 24-hour basis to the work of 234,000 men.

Shortly afterwards the turbine had begun its meteoric career: Charles Parson's original designs rapidly developed into units of 700, then 5,000 h.p. Today units of 60,000 h.p. are a matter of course, with a thermal efficiency in the best stations of less than one pound of coal per kilowatt hour. Even this is a trifle compared to the 300,000 h.p. units we now operate, which means that a single compact, continuously operating mechanism can perform in 24 hours the work of 9,000,000 men — or nearly double the estimated maximum population of ancient Egypt. Should it be necessary, turbines of 1,000,000 h.p. can be built, representing at capacity the human labor output of nearly half the normal working population of the United States before the depression.

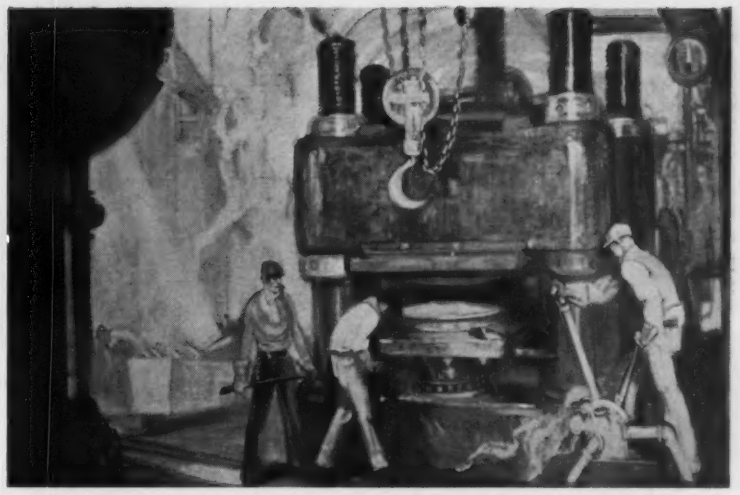
Detailed researches now being actively carried on by Technocracy are planned to cover the "energy flow" as expressed in the production of 3,000 separate commodities, industrial and agricultural, of the United States and Canada. Over 300 sets of tabulations and charts have already been completed, giving accurate information on such vital factors as: rate and quantity of production; number of establishments and workers; installed horsepower; total man hours required in production over a given time; extraneous energy and man hours per unit of commodity produced. Wherever possible, these statistics are carried back to 1830, and in their massed totality will constitute the most powerful and exhaustive body of evidence relating to the impact of technology on social life ever assembled.

For example:

In the Spanish copper mines of the Roman Empire, thousands of slaves, working with their bare hands and the most primitive hammers, extracted ore at the rate of a few baskets per man per long day. In the United States, in 1930, one man could account for four tons of ore per hour; as many of the plants could run continuously, this meant 96 tons per capita per day. On the Mesabi range four weeks was sufficient to move a greater tonnage of ore than the total weight of the Great Pyramid of Gizeh, which required the labor of 100,000 men working for three months in the year for twenty years.

Until 1855, working on the soil in the sweat of his brow, a farmer required 96 hours to till one acre. Today huge 60-duck-foot power tractors can handle over a thousand acres in that time, or one acre every five minutes. Soil preparation for the 1919 wheat crop of 3,464,000 metric quintals (spread over 29,000,000 hectares of land) would have required nearly 5,000,000 men working with the spade. Actually, this production could be managed by only 5,360 men using combines.

Adam Smith's "broad-wheeled wagon, attended by two men, and drawn by eight horses" required about three weeks to carry four tons of freight from London to Edinburgh; in 1932 the railroads of the United States accomplished 340,000,000 ton miles, and this with the same number of workers (1,000,000) as in 1900, when the ton mileage was only 140,000,000. Furthermore,



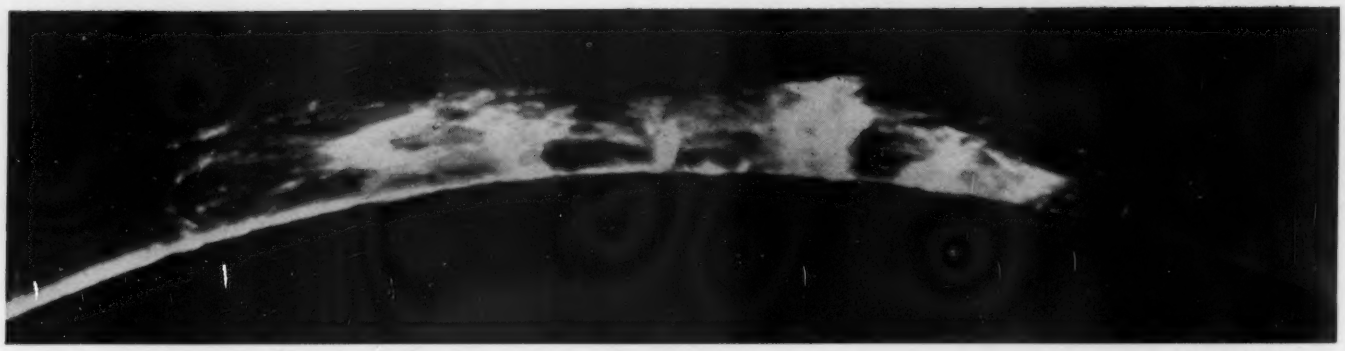
the new "K-1" locomotives are now hauling loads of 7,500 tons, with a train crew of about five men. A similar load, carried in the heavy wagons of classical times, would require from 10,000 to 15,000 vehicles, each drawn by two oxen or horses and attended by its driver, to say nothing of the commisariat and constant replacement of slaves, animals and equipment.

In 1905 cement production in the United States amounted to 35,000,000 barrels, or a rate of 1.75 man hours per barrel. Twenty-five years later, in 1930, production had increased to over 161,000,000 barrels, while the man hours per barrel had decreased to 0.32: one barrel every twenty minutes for each worker.

Glass was produced in 1900 at the rate of 207 man hours per metric ton of glass; in 1929 there were 92 fewer establishments, producing more than three times the 1900 quantity at a rate of only 70 man hours per metric ton.

Steel production in 1900 was at the rate of 70 man hours per ton; in 1929 only 13 man hours per ton.

(*Continued on page 159*)



Photograph by Lick Observatory

An active solar prominence, photographed at the 1905 (Spain) total solar eclipse

THE SUN—AN ENGINEERING MASTERPIECE

By DR. DONALD H. MENZEL
Solar Physicist, Harvard Observatory

WHEN an engineer undertakes the design of some great machine, there are a number of items that must come under consideration. What is the machine for? Perhaps it is a huge dynamo, destined to furnish heat and light for a great city. How much power must it give? There is the question of economical operation, which includes the efficiency, long life, and reliability of the mechanism. In the broadest sense of the word, the sun is a machine, a dynamo in fact, which furnishes light and heat not just to a city but to the universe as a whole. True, it is not man-made. It is not a combination of wheels, levers, and wires. Nevertheless, deep below its surface, there is some sort of mechanism for manufacturing energy. We do not know of just what this consists, but we know it must be extremely powerful. Its rating is five hundred sextillion horsepower, or 80,000 horsepower for every square yard of the solar surface. Only one part in 2,200 millions of the total radiated energy actually strikes the earth, but even if the fraction falling per day upon an area one mile square could be converted into electricity at the low rate of one cent per kilowatt hour, its value would be more than two hundred·thousand dollars.

The reliability and permanency of the sun is remarkable. Frozen in the rocks is a continuous record of life upon the terrestrial surface — from the age of delicate protozoa and animalculae, through the period when the earth was dominated by dinosaurs and other mesozoic reptiles, and on to the modern era and civilized man. Throughout this enormous epoch — a billion years or more in length — there is no evidence of the sun's having been shut down for repairs. During this time the intensity of solar heat has never increased to twice or fallen to half of its present value, otherwise the continuity of the geological record would have been broken. This means that each gram of the sun has, within the lifetime of the earth, accounted for more than a billion calories, which is more than a hundred thousand times greater than would be produced by complete combustion of an equal mass of pure carbon and oxygen or, for that matter, by any other chemical process. The magnitude of the energy source is one that may well arrest the attention and the imagination of the engineer. If he could only discover this method of energy production and harness it for mankind, all questions of power supply would be solved for future generations.

The second fact that may be of particular interest to the engineer is the efficiency with which the sun gets rid of its heat. It is well known that the rating of a steam engine depends upon the difference in temperature between the boiler and condenser, and that one hundred per cent efficiency can be realized only when the condenser is at absolute zero. Few machines today operate with an efficiency greater than twenty-five or thirty per cent. The sun, radiating as it does to space where the temperature is almost an absolute zero, comes within a billionth of one per cent of having a rating of one hundred per cent. The sun, it would seem, is as nearly perfect an engine as one could conceive.

We are too accustomed to take the sun for granted. The sun arose this morning as it has for numberless mornings in the past. Its long period of reliability in this matter makes the rising of it tomorrow morning almost a certainty. *Almost!* The sun's store of energy, vast as it is, cannot be inexhaustible. Perpetual motion is as impossible on the cosmic scheme as it is terrestrially. Perhaps the last shovelful of coal has already been thrown into the solar furnace and the only energy still to come from that great body will be the questionable warmth of hot ashes and dying embers. If this should have occurred, how long will it be until the sun will fade and until frost-bitten civilization will be faced with annihilation? The engineer, above all, should ask these questions, because, when the world comes to this condition, upon his shoulders will fall the responsibility of preserving civilization — if that is possible.

To answer these questions we must delve beneath the solar surface, which, at first sight, seems an impossible thing to do. Nevertheless, we have at hand two facts about the interior of the sun. First of all, the heat that leaves the surface has had its origin far below and, though it has had to work its way slowly outward, much as water may seep through the ground, it may still bear some trace of its birthplace. Second, matter at the sun's

Of the author of this article Dr. Shapley, Director of the Harvard Observatory, has said: "He is one of the foremost authorities on solar physics in the United States today." That the author in addition is able to write about the Sun as interestingly and as informally as he has done here makes the article of particular significance. It was written at the joint request of the Editors of the TECH ENGINEERING NEWS and *The Journal of the Engineering Societies*, in which latter publication it will also appear. — THE EDITOR.

center exerts a gravitational force that is in no wise diminished by the overlying layers and we can measure the total mass of the sun from the magnitude of this force — the same force that causes the earth and the other planets to move in curved paths instead of straight ones. These are the clues. To them we add such well-known principles of physics as the gas laws of Boyle and Charles, the law of gravitation, the laws governing the absorption and emission of radiation, etc. Application of these tells us at once that the sun must be very hot at the core. Calculated temperatures exceed 10,000,000°. The precise mathematical reasoning is somewhat complicated, but it is easy to see why this must be so.

If you are skeptical, let us try to build the sun out of material at its surface temperature, 6,000° C. Since, at this temperature, all substances are gaseous, the structure of the outer layers will be analogous to the structure of the earth's atmosphere, getting denser and denser at lower levels. Starting where the pressure is about one-hundredth of an atmosphere and going through a layer one hundred miles in thickness, which is only about one five-hundredth of the solar radius, we should reach a point where the density exceeds ten grams per cubic centimeter. And, even if we assume that no further increase occurs because of the jamming of the atoms, with a given amount of matter in the sun, we should run out of building material long before the sun's center is reached. A sun so constituted would, like a building without a foundation, be structurally unstable. It would collapse to form a ball perhaps not much larger than the planet Jupiter. This ball could, however, be made to swell to its observed size if enormous quantities of heat were supplied its core.

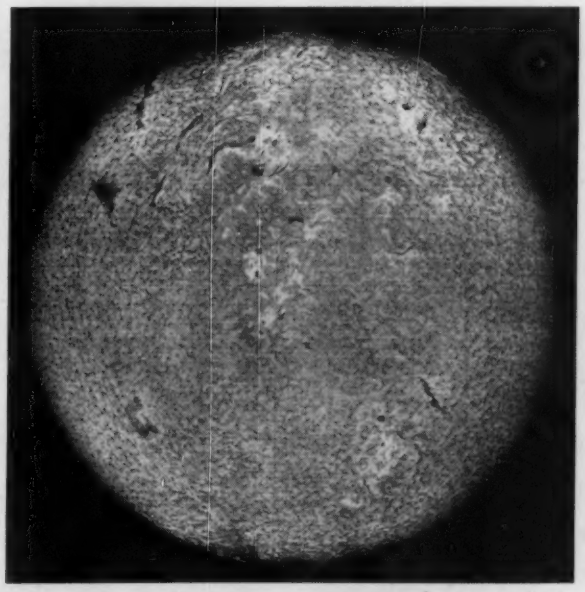
There is an even more specious argument for high interior temperatures. If the sun were, at a given moment, at 6,000° throughout, the outer layers would lose heat faster than it could be relayed to the surface; a temperature gradient would automatically be set up and the surface temperature would fall. To maintain the outside at 6,000°, therefore, requires much higher internal temperature. The hot core of the sun is surrounded by a layer of cooler insulating material, which retards the flow of heat to its observed amount. The large store of internal heat is a guarantee that, even if energy sources of the sun were to fail, it would still continue to shine for many millions of years. Of course, this does not exclude the possibility of a catastrophic collapse, for we do not know how much the stability of the sun depends upon the maintenance of the solar fires, but such a collapse seems most improbable.

It is unfortunate that we do not know more of the mechanism that gives birth to the solar heat. As mentioned above, it cannot result from chemical activity, such as combustion, not only because these are far too inefficient, but because the sun is too hot to burn. If we were to transport to the sun large quantities of water vapor, carbon dioxide gas, and other products of combustion, at the high prevailing temperatures, they would become dissociated into their original elements: carbon, oxygen, etc. There are a few other processes that may conceivably replenish the energy lost by radiation: the falling of meteors into the solar atmosphere, gravitational contraction with resultant heating by compression, radio-activity, etc.— and we are forced to discard all as inadequate. We seem to be driven to accept the view that the sun's supply of heat is produced by actual conversion of mass into energy, *i.e.*, by annihilation of matter. The equivalence of mass and energy is fundamental in the theory of relativity. A single gram of matter corresponds to 10^{21} ergs or about 2×10^{13} calories. Annihilation of a thimbleful of gasolene would produce more energy than ordinary combustion of a million gallons of the substance. In this way, the sun must be gradually losing mass. But, at its present rate of radiation, the sun still has enough mass left to provide energy for ten trillion years to come. Of course it is not certain that all types of atoms are so convertible. Perhaps the process is one of atom building of the type recognized by chemists and physicists, where $4\times(1.0078)=4.0312$ grams of hydrogen contain exactly the same fundamental particles as 4.0022 grams of helium. The difference, 0.0290 gram, represents the energy of binding which would be liberated as heat if hydrogen is being built up into helium deep in the sun's interior.

The turbulent surface of the sun may be an index of the activity of these energy sources. The accompanying photograph (Fig. 1) shows what hydrogen is doing in the sun, and, since, according to recent work, it turns out that the sun is close to one hundred per cent pure hydrogen with only a trace of other elements, it shows what most of the solar surface is like. Figure 2, taken of the edge of the sun at the time of a total solar eclipse, exhibits how these fiery, but not flaming, gases are shot, geyser-like, sometimes hundreds of thousands of miles out into space. To interpret the structure and motion of these jets and also of the tornadoes commonly called sun-spots requires an extensive knowledge of hydrodynamics.

The problems of solar research are many, and are worthy of recognition by the engineer. Every source of energy now known to man, with the possible exception of radio-activity, came originally from the sun. And, even if the scientist is unable to reproduce in the laboratory the conditions that give birth to the solar energy, there still remains the important and as yet unsolved problem of finding a way of converting directly into a useful form the enormous quantities of heat and light that daily fall upon the terrestrial surface.

That solar research is a practical pursuit can scarcely be doubted. In the past it has resulted in such achievements as the discovery of helium. In the future we can hope it will lead to a more efficient utilization of the vast energy which the Sun provides. Such a goal is worthy of the interest and support of every engineer, whose job it is to direct the energy available.



Photograph by Mount Wilson Observatory

The Sun. A photograph taken on August 12, 1917 which shows the hydrogen on the surface

The Business Press

HELPS INDUSTRY *to Build Itself*

By *LEONARD H. CHURCH*
Assistant to the Vice-President and Editorial Director
McGraw-Hill Publishing Company, New York

A NEW kind of journalism has developed with the industrialization of the United States. It includes all publishing endeavor having to do with the specialized aspects of business, industry, and commerce, and is variously termed "industrial," "engineering," and "technical" journalism. The approximately two thousand publications which may be grouped under its heading have more recently come to be called "business papers."

We are in a day of very searching analysis of industry and trade. Competition is so severe and business so complex that success in industrial and commercial enterprises depends on keeping abreast of the factors that bear on business. Since the great war this searching study of business has been directed especially at the agencies and processes of distribution; for productive capacity is now greater than demand, and the chief concern of industry is to find or create markets, and to sell in those markets with the least possible waste.

If this be one of the characteristics of the present business age — that every factor receives careful scrutiny and analysis — then the engineer, the industrialist, and the business man must examine and know intimately the business press, must learn what it does, how it does it, and with what manner of men it works.

The distinguishing characteristic of a business paper is that it serves a specific group of men having similar needs for business information. It is bread and butter journalism in the truest sense of that expression, for it undertakes to accelerate and rationalize the whole development of business and industrial practice by disseminating technical knowledge, and to make available at once to all industries the most advanced practice existing anywhere in the field.

Business papers are newspapers of practical education concerned with some branch of the world's productive work. Such a paper may serve an industry, as the production of coal; a specific field of trade, as the distribution of electrical equipment; or a scientific art such as civil engineering construction. In each case the readers of the paper depend upon its information and educational service for help in their daily work. Accordingly, its major activities and plans are directed toward giving a news service broad in coverage, informing in selection, true in character, factual in treatment.

The successful business paper possesses authority with respect to that common interest of its readers — technical, industrial, or commercial — upon which their business life depends. But it claims no right to speak of their diversions, politics or religion.

Photographed by Duntley for T.E.N.

Technical journals — as a division of business publications — are directed primarily to audiences consisting of engineers, technical specialists, and executives in industry. A technical journal stresses the advantages to be gained by improved technical practices, as a factor in efficient and economical operations. It serves a profession as well as an industry. Its editorial pages show greater professional discrimination, more trenchant criticism, more scientific treatment of material than a trade paper will have occasion to do.

The trade paper, on the other hand — as another great division of business papers — is primarily concerned with the movement of commodities, their prices, market opportunities, sale possibilities, and sales technique. *Electrical World, Engineering & Mining Journal*, and *Engineering News-Record* are examples of technical publications. *Electrical Merchandising, Printers' Ink, Radio Retailing* and *Advertising and Selling* are trade papers. It must be borne in mind, however, that the distinction between the technical and the trade paper cannot always be made clear-cut. With all due respect to definitions, business papers will be found which combine in varying degrees the function of both these classifications.

The business press is: first, a collector and distributor of information; second, an interpreter of events and trends in its industry or profession; and third, a promoter of sound thought and policies.

The collection and distribution of information relates to two large classes of reading matter. First, to "practical information," which answers the questions of "how" and "why" and "with what." Articles in this classification relate to design, manufacture, construction, operation and merchandising. Included also in the material are such departments as "patents," "book reviews," "digests of literature," "letters to the editor," "questions and answers," etc.

The other large division of reading matter is the news, which may be general in character, or may relate to finance, markets, forthcoming contracts, prices, the men of the industry, new equipment and appliances.

The business paper gathers up information in these two major classifications from all parts of the United States and of the world. It is a merchant of ideas, and it scours the world as does a Wanamaker or a Marshall Field.

(*Continued on page 160*)

The Composition of

PRINTING INK

and Its Characteristics

By CARL E. FOSS

The International Printing Ink Corporation

PRINTING INK is a material composed of a pigment dispersed in a vehicle and is the medium in all transfer operations which are classified as typographic, lithographic, and intaglio processes. The construction of printing ink varies for use in each field and ink for one process will resemble but little the ink used for another process.

A more comprehensive view of the variations of printing ink composition can best be had by relating in general the principles involved in the three major processes of printing. In the typographic process, generally referred to as letterpress printing, the impression is made from a relief plate whose top surfaces are inked. Raised type and raised plates on which the non-printing areas are etched out are used in this field. All general printing comes under this classification.

In lithography a plane surface is used, but this surface is so treated that only certain sections of the plate are receptive to ink and are the only parts which transfer such ink. This transfer can be had either direct or by offsetting to a rubber blanket which in turn transfers the ink to the stock.

In intaglio printing the plate used has the areas to be printed etched out. The ink is applied heavily so as to fill all parts and then the surplus is scraped off leaving the top surface without ink which consequently makes no transfer. The transfer of ink is made only from the filled areas of the plate.

Each of these classes of printing also have many variations of procedure, all of which require differently constructed inks.

In letterpress work, as in other cases, inks with vehicles especially constructed for the work are used. The vehicles must carry the pigments evenly and continually throughout all the units of the press and must be readily received by the stock used. These inks usually dry by the oxidation of the vehicle and in some cases by the absorption of the vehicle by the stock.

In lithography, the inks must also work successfully on the units of the press and have an affinity for the stock. They almost always dry by oxidation. In intaglio work, the ink must transfer to the stock and dry either by the absorption or evaporation of the vehicle. The vehicle is the governing factor in ink if, at this time, the pigment is considered a constant in all cases.

The vehicles used in ink manufacture are principally the following: Linseed oil and other vegetable oils, rosin oil, mineral oils and volatile solvents. Linseed oil is the best vehicle primarily because of its bodying and drying characteristics. It is obtained by compressing the seed of the flax plant and consists principally of unsaturated fats or glycerides. Linseed oil dries very slowly in its natural state and because of this it has very little use in printing ink, but this oil is used by the varnish maker in producing appropriate vehicles for printing ink. These so-called "lithographic varnishes" are prepared by heating the oil to about 550° F. for several hours. The viscosity of the varnish is increased by this polymerization process by increasing the time of heating. Long continuance of the treatment will produce a very viscous mass, much like rubber. Generally about ten definite bodies of varnishes are used in printing ink manufacture. This range of viscosity is necessary to compound inks correctly for the general range of paper surfaces and printing processes.

Various other vegetable oils such as China Wood Oil, Soya Bean Oil, Perilla, Cottonseed, Hempseed, Rape Seed Oil, etc., are sometimes used for vehicles and each has some definite characteristic that may be desirable in certain inks.

In order to produce varnishes with better adhesive properties and with other desirable characteristics, various natural and fossil resins such as Damar, Kauri, etc., and various synthetic resins as Cumar, phenol condensites, etc., are cooked with linseed oil to varying bodies also. This class is known as gum varnishes. A better gloss and harder film is characteristic of certain varnishes of this class.

Rosin oil is a distillation product of pine pitch and many grades are available, ranging in color from a black oil to a pale oil. Rosin oil is used mostly in black inks. The drying is accomplished by oxidation.

Many varnishes are made by combining such mineral oils as paraffin base oil or asphalt base oil with rosin or a brittle asphalt known as Gilsonite.

Printing inks made with these vehicles find use in all phases of letterpress printing, the controlling factors being conditions and quality desired. In lithography the vehicles are lithographic varnishes. Occasionally gum varnishes are used but to a limited extent. In intaglio printing the vehicle is usually composed of various gums and a volatile solvent such as naphtha, xylol or benzol.

The oxidation rate of the better grade varnishes (linseed and gum) may be varied at will. If we wish to increase the drying rate we add either metallic soaps or spirit driers as the case may need. The metallic driers are in paste and liquid form, i.e., lead and manganese in paste and cobalt in liquid. The action of the metallic radical is only as a catalyst. The spirit driers are usually Japans and have some volatile substance in them. The retardation of drying is produced by adding materials such as vaseline, lanoline, waxes, mineral oils, or non-drying vegetable oils.

These generalities cover the case of vehicles and the next step is to consider the pigments.

The pigments used are both inorganic and organic in nature. The inorganic pigments can be divided into two definite classes, i.e., natural pigments and artificial pigments. The natural pigments commonly used in printing ink manufacture are Barytes, Whiting, Kaolin, Raw Umber, Raw Sienna. With the exception of Kaolin these pigments are all hard and gritty substances and find their way into the poorer grades of inks. The Umber and Sienna may be burnt, in both cases producing darker colors which are still quite workable.

The artificial inorganic colors are: Ultramarine Blue, English Vermilion, Orange Mineral, Chrome Green, White Lead, Chrome Yellow, Chrome Oxide Green, Iron Blue, Zinc Yellow, Magnesia, Zinc White, Lithopone,

YELLOW

RED

THE illustrations on this page show the steps the printer follows to obtain the reproduction of a subject in its original colors. The method shown is known as "Four Color Process." A "Three Color Process" in which the black is eliminated is also used but to a lesser extent. The procedure followed by photoengravers in producing these printing plates is essentially the same in each process.

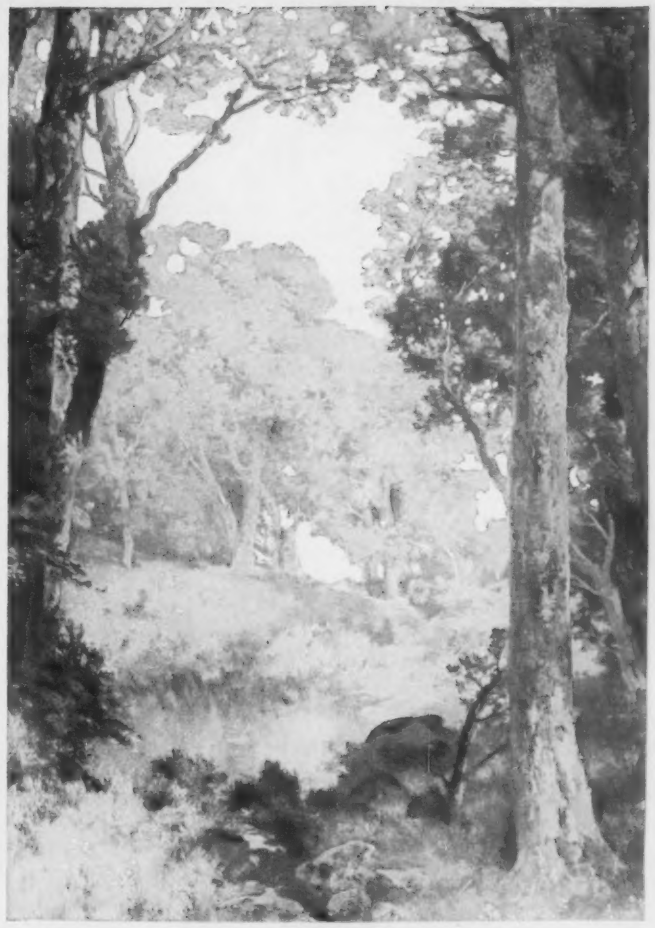
Three color separations are made by photographing the subject through three color filters and a halftone screen set at different angles of orientation. The halftone screen at different angles allows the dots of each plate to fall between the dots of the other plates. The color filters used correspond with the additive primaries, i.e., red, green and purple-blue and the negatives from which printing plates are etched are printed with inks that are complementary in color to the filters used. For example, the printing plates which are produced from the image through the red, green and purple-blue, filters respectively, are printed with blue-green, red-purple and yellow inks, respectively. In this manner, by the subtractive principle a very good reproduction of the color is had.

The black printing plate used for "Four Color Process" is produced from an image through a yellow filter dependent upon the character of the subject and is used for detail and to strengthen the dark areas, which for want of ideal printing inks are not as dark as they should be. The detail is dependent upon the fineness of the halftone screen and is helped considerably by a black printing plate.

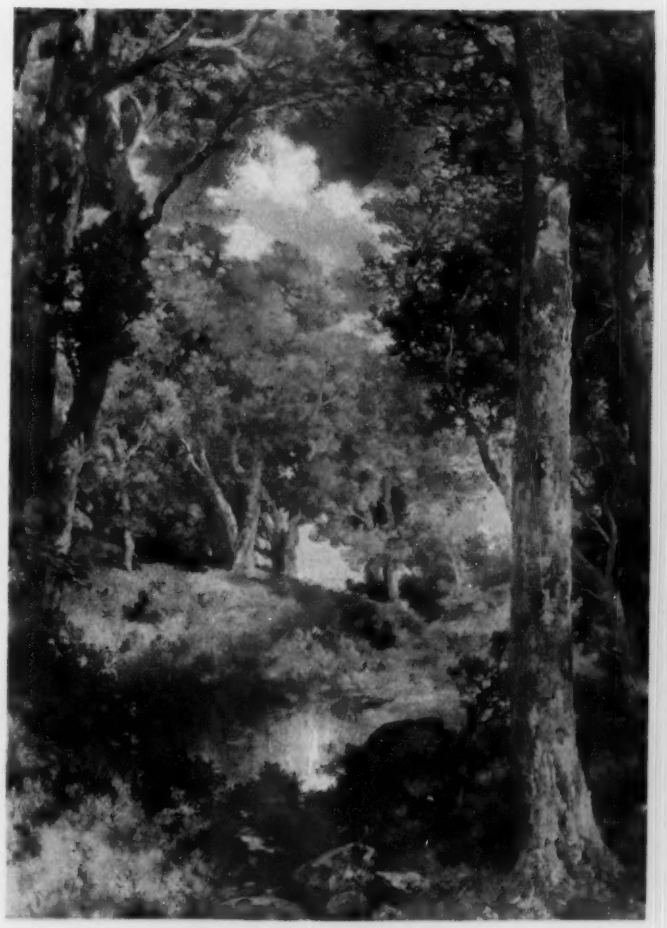
By varying the hue of each ink, a particular color in the reproduction may be increased in saturation and made to correspond more closely with the original.

RED OVER YELLOW

BLUE



BLACK



BLUE OVER RED AND YELLOW

BLACK OVER BLUE, RED AND YELLOW

Blanc Fixe, Alumina Hydrate, Cadmium Red, Cadmium Lithopone and precipitated Iron Oxide Black, Brown, Red and Yellow.

Iron Blue is by far the most important blue. There are various shades of this blue, all of them being ferricyanides. Some of the trade names are Prussian Blue, Chinese Blue, Steel Blue and Bronze Blue. The Iron Blue pigments make inks which are relatively fast drying. In many cases greases are added to retard the drying to a normal rate.

Ultramarine Blue is the next most important inorganic blue and is made by fusing China Clay, Silica, Soda Ash and Charcoal. It has many desirable chemical properties although it is very gritty and can be used only in certain classes of work.

Chrome Yellow is our most important yellow. It is a lead chromate. Various shades from lemon yellow to orange are produced by slight modifications in the manufacturing process. The lemon yellows are precipitated in acid solutions and when the solution is changed to basic the pigment becomes more orange. The dark orange colored varieties are strictly basic chromates. Varying conditions of precipitation vary particle size, producing both fine and coarse pigments. Zinc Yellow is often used and is a zinc chromate. Cadmium Lithopone is also an excellent yellow pigment and is produced by the simultaneous precipitation of cadmium sulfide and barium sulphate. The most important inorganic green pigment is Chrome Green. It is produced by the simultaneous precipitation of lead chromate and ferric ferrocyanide. This green has many desirable characteristics. Chrome Oxide Green has also found its way into printing ink use. Orange Mineral is a lead oxide and finds extensive use in low priced printing inks. English Vermilion is a mercury sulfide. It is relatively expensive and has many desirable qualities. Cadmium Red is a cadmium selenide and also has many excellent characteristics.

The organic pigments are very many in number. Today almost all organic pigments used in printing inks are artifically produced. There are two classes of organic pigments, those that are precipitated alone and those that are precipitated on a base.

The most important organic pigments are: Rhodamine, Eosine, Lithol Rubine, Lithol Red, Scarlet, Red Lake C, Para Red, Fire Red, Orange II, Napthol Yellow, Hansa Yellow, Acid Green, Malachite Green, Setoglaucine, Alkali Blue, Patent Blue, Methylene Blue, Victoria Blue, Indigo, Methyl Violet, Alizarine Purple, Madder Lake and Bismark Brown. Each of these pigments is available in various shades and each one may have different characteristics.

The blacks commonly used are Lamp Black and Gas Black. Gas Black is obtained by burning an hydrocarbon gas in a limited supply of air. Almost all black used today is of this kind.

Lamp Black is obtained by burning an oil in a limited supply of air. Lamp Black differs from Gas Black in that it has a higher oil absorption. Bone and Vegetable Blacks and Iron Tannates are the other black pigments that find a lesser use in inks.

The white pigments are in two distinct classes, i.e., those that produce opaque inks and those that produce transparent inks. The opaque whites are Zinc White, Lithopone, White Lead, Titanium Dioxide, Antomony Oxide, etc. The transparent whites are Magnesia and Alumina Hydrate. An intermediate series would include Blanc Fixe, Barytes, Whiting and Kaolin. The degree of opacity of an ink is dependent on the difference in refractive index of the pigment and the vehicle. The greater the difference, the more opaque the ink will be.

It is very necessary to have many kinds of blacks, whites, reds, greens, yellows, blues, etc. because of the difference in strength as well as the difference in chemical and physical properties. The usual property tests for pigments are: permanency to light (actual outdoor tests and indoor fadeometer tests), acid and alkali, alcohol and paste.

In the acid test a weak acid such as vinegar is used; in the alkali test a two per cent caustic is used. The alcohol test is for an exposure of short duration as in spirit varnishing, while the paste test is made by stroking a neutral paste over the printed areas.

Many other tests are often necessary, such as wax, brine, lard, butter, baking, cheese, sterilization, etc. Each pigment has a definite set of properties and if it happens to be fugitive to any one it is useless in that particular field.

All these properties are taken with the vehicles as a constant. Very often we find that a pigment will react with a vehicle to render it unusable and very often certain pigments will not work together. Ultramarine Blue, for example, cannot be used with lead colors because of its sulfide sulfur.

Basic lead chromates tend to react with the linseed oil to form lead soaps. This causes the oil to become jelly like, it is said to be "livered."

If transparent inks are required to attain certain color effects with a minimum number of impressions it will be found that, if these points are gained, other characteristics may be lost.

All in all the combination of pigments and vehicles does present a problem which is quite specialized. The only satisfactory manufacture of ink calls for very accurate control of the ingredients as well as the finished product.

The actual manufacture of printing ink requires rather simple processes. The mixing of the pigment and vehicle is done by machines much like dough mixers. A better dispersion is then gotten by grinding machines which consist of from three to five heavy steel rolls that revolve at varied speeds and are arranged so as to give a surface at which the pigment is dispersed in the vehicle.

Colloid mills are used to disperse carbon black in the more fluid varnishes or oils. A ball mill is used to disperse a pigment in a volatile solvent. Occasionally various other methods are used but not a great deal.

The manufacture of printing inks for the multitude of uses presents a rather involved problem, but marvelous progress has been made in the last decade. Improvement in the design of presses has made greater speed possible and the inkmaker has been fortunate in keeping up with the new strides. He has been able to construct inks that will print on such materials as cellophane, celluloid, glazed paper, artificial rubber, artificial leather, metal coated paper, etc.

Printing is a part of the livelihood of everyone. Every newspaper, magazine or book is evidence of the use of printing ink. The people in this country have an enormous ration of ink. Over one hundred million pounds are used annually. This figure can be made to appear of even greater significance when the coverage of a single pound of ink is considered. For example, one pound of high grade black ink will print twenty thousand copies of the type matter of this insert. Other inks vary in coverage to about half this figure.

Over half of the consumption of printing ink is by the newspapers and the next greatest use is for cartons. The cost of printing ink comprises about three percent of the total cost of a printed job and although ink appears to be of little consequence, it really is a vital factor in the sixth greatest industry namely, the Graphic Arts.

ENGINEERING DIGEST

Condensation of outstanding articles in the trade and scientific journals, published by special permission

MARINERS' AID

Journal of Acoustical Society of America, *October, 1932*

BOMBS have often been used to destroy ships at sea, but now it is the style for a ship's captain to order an explosive to be set off near his own vessel. The execution of this surprising command is, however, only a part of an up-to-date method of position finding.

Simultaneously with the firing of the bomb, a radio signal is transmitted by the operator on the vessel whose position it is desired to determine. These two signals are received by stations whose positions are accurately known, and the difference in the time between the reception of the radio and sound signals is observed. Then, knowing the velocity of propagation of sound through sea water — the time of travel of the radio signal may be disregarded — the distance of the ship from the reference station can be determined and communicated to the ship. When two or more such stations send their observations to the ship, its position can be found by triangulation. By the use of this method a position 206 miles off shore has been determined. The advantages of the system are particularly apparent during foggy weather or where fogs and haze prevail for long periods of time.

The use of subaqueous sound ranging, as the method is sometimes called, is not limited to the determination of ship positions in which the coöperation of reference stations is essential. Frequently the mariner uses a sound ranging method to determine, entirely unaided, his approximate position. By detonating a bomb and measuring the elapsing time before the echo from the bed of the ocean is received at the ship, a sounding is made. By means of a series of such soundings, the contour of the bottom of the sea over which the ship passes is revealed, from which its position may be determined, if one refers to mariners' charts. Ambiguity in reckoning ship locations by means of hydrography rarely occurs because the ship's course is always known with reasonable accuracy. The success of this method of position finding obviously depends upon the accuracy of the mariners' charts.

Another interesting application of sound ranging is the determination of the point of impact of a projectile fired from major calibre coast artillery. The theory underlying this application depends upon the fact that the impact of the projectile sets up sound waves which travel in all directions below the surface of the water. Through the use of several receiving stations which are interconnected with rapid means of communication, the point at which the projectile strikes the water may be found by triangulation, and the direction of fire changed if necessary.

HARD OF HEARING?

The Electrical Review, *October, 1932*

DESIGNED to overcome the handicap of deafness, and at the same time to satisfy the popular demand for an inconspicuous appliance, manufacturers have of late produced instruments small enough to fit snugly into the auditory cavity. Their diminished size, however, has resulted in a marked inefficiency in their power and quality of amplification. Experimentation by Professor E. D. Adrian of Cambridge University may result in the manufacture of an instrument that will overcome this disadvantage. Professor Adrian tapped the auditory nerves of a cat with two electrodes, connecting them to an amplifier and a loudspeaker. He found that anything spoken to the cat was reproduced perfectly by the loudspeaker, a result which showed that the electrical output of the nerve was identical with the original sound. It is easily seen that, though a person may be stone deaf, if electrical impulses caused by a certain sound may be transmitted to the auditory nerve, the patient should receive the same sensation as when the sound is heard directly. The energy necessary to produce such impulses, incidentally, is of a very small order. Invisible electrodes, a very small microphone and battery, and the aid of the medical profession would be the requisites for the success of this method. It is not improbable that in the future patients equipped with such instruments will have their hearing restored to a degree heretofore unapproached.

(*Continued on page 161*)

FLYING IN YOSEMITE

This Pitcairn autogyro is one of the few aircraft which have descended below the rim of the precipitous walls surrounding Yosemite Valley, Yosemite National Park, California. The valley is seven miles long and only one mile wide, with a single entrance at the western end. What an experience it must be to ascend smoothly by air near the broad vertical face of El Capitan which reaches 3600 feet above the valley floor, and to master in a few minutes the height of Yosemite Falls, 1430 feet, equivalent to nine Niagaras!

Aviation

The TECH ENGINEERING NEWS

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EDITORIALS

LAST BOW — WITH FLOURISH

IN this, the final number of Volume XIII, the present Managing Board of the T. E. N. makes its last bow. But, before turning over the reins to those who will direct Volume XIV, we point with pardonable pride to the fact that this last bow is made with a considerable flourish. We refer, of course, to the color plates which appear on pages 152 and 153 of this issue. For the second time in its career, T. E. N. presents illustrations in full color. In 1922 color plates were used to illustrate that very colorful art, the analysis of stress in structural members by means of polarized light. In this issue we illustrate the process of color printing itself.

We wish to make grateful acknowledgment to the International Printing Ink Corporation, and to the author, Mr. Carl E. Foss, for making it possible for us to publish this fine article with its illustrations. The entire writing, typographical composition and printing of the four inmost pages of the magazine were done by the I. P. I. organization, without cost to the T. E. N., and without a request for publicity of any kind. We feel, however, that this corporation richly deserves the appreciation of the T. E. N. and its readers. Long the largest manufacturer of printing ink, and a pioneer in educating the technical student to the importance of this industry, the I. P. I. Corporation has shown another example of its coöperation with the college world of America in this fine gesture on our behalf. We wish here to thank the Corporation, and Mr. Foss, for their assistance in making this issue what we believe it to be, a landmark in the history of THE TECH ENGINEERING NEWS.

"CALM COURAGE, BREADTH, BALANCE"

FROM a letter written by a M. I. T. graduate in the class of 1907, we quote the following two paragraphs:

"An interesting question and one worthy of more attention is suggested by the editorial on 'Spiritualism' in your December issue: Why is it that when confronted by phenomena which, for the time being, he cannot explain, your physicist — practically alone among scientists — becomes maudlin and 'goes Eddington'?

"I wonder if it would not be to the ultimate gain of science if our students should devote some of the time now spent on 'humanics' and academic economics to an endeavor to appreciate and absorb a little of the calm courage, the breadth, and the balance of such exponents of the scientific spirit as John Tyndal and Thomas Henry Huxley."

Whether or not the writer is justified in singling out the physicist for his indictment, it is certainly true that he raises a most important question. Scientific progress, just as truly as any type of progress, requires the unfaltering faith of those who lead and of those who follow. Faith, not founded on the blind acceptance of a preconceived ideal, but the faith of courage, breadth, and of balance is a vital factor in the furtherance of the scientific plan. Sadly enough, such faith is not forthcoming without effort. The tendency is in quite the opposite direction. The emotional make-up of each of us, fostered by the forces of organized society, is only too ready to accept the mystical, untried, unproven findings of an emotion-ridden world. If we are to achieve the "calm courage, the breadth and balance of a Tyndal or a Huxley we must train ourselves to it.',

Few enough technical students have a clear idea of the meaning of science and its methods, let alone any conviction that it is worthy of unflagging support. Apparently little effort is being spent by the scientific institutions of the country to make that meaning clear, or to instill such a conviction. A few of the great teachers, by their very enthusiasm and grasp, are able to pass on the scientific faith to those few who lie within the sphere of their influence. But their influence is pitifully restricted. If we are to organize science, if we are to accelerate its progress, we must vitally interest scientific students in their chosen field, *for itself*, not for what it means to them individually.

To carry out such a program is admittedly difficult. But a first step in the right direction can easily be made. If a certain part of the time consumed in each course were to be devoted to the historical background of the subject, to the lives and accomplishments of the great men who have built it, in a vital, interesting way, the student would immediately take interest in the subject *for itself*. The advantages are manifest. Nothing is more gratifying nor more stimulating to a teacher than an enthusiastic student. And an enthusiastic student usually develops into a capable and valuable man.

It still remains that words are cheap. A plan for the improvement of educational methods may be potentially beneficial. But it does not become actually beneficial until something is done about it. In a few widely scattered courses, the teachers at Tech are making an honest effort to interest the students, rather than simply to instruct them. But there remains much to be done. Romanticised education may sound silly and impractical, but it is surely coming. Why should we wait for the inevitable?

U. S. Navy from the Sportsman Pilot

INTERNATIONALE

ONE mark of a well-educated man is his tolerance of all things foreign or strange, his impatience with narrow provincialism, his loyalty to his native land, not in the sense of unthinking patriotism, but as a citizen of the world: in all, the true charity of internationalism. Men at Technology are graduated with the understanding that they have received a good education. We must admit, alas, that this training has failed in one of its most important purposes if our study and research has not imbued us with a sense of worlds outside our own, with tolerance and with a healthy curiosity, with a scorn for the idolatry of one tongue, one creed, one people.

What a blessed miracle it would be if all men suddenly became cosmopolites in the best sense! Wars would be as obsolete as pterodactyls. What need for organized bloodshed when all are content to respect each others' views? No more agonized notes of harassed diplomacy winging across the seven seas; no more mountainous taxes for armoured battleships, for gaudily apparelled professional murderers; no more generations blighted and maimed by the horror of war. It is not inconceivable that there would be no more depressions. A worldwide economic council, to replace the useless and antique peace-leagues, would, together with the removal of the petty barriers of tariffs and duties, go a long way toward a more perfect world economy.

"Utopia," you say, "impossible achievements."

We need men who do not countenance the word "impossible." We, who have the advantages of education, should be in the forefront of the march toward international brotherhood. Not from an easy-chair, but by intelligent interest in and hearty support of every measure to further world patriotism can we prove that we are worthy of the position to which our education entitles us.

RACIAL PROGRESS

LIKE father, like son" is a proverb not entirely exploded by chromosomes and hormones. Nevertheless, the objectively-minded experimenter, while recognizing the principle of breeding by selection, has not applied to himself the methods which have been so successful in horticulture and in the breeding of domestic animals.

The natural result of this shortsightedness is the unfortunate fact that the stratum of society productive of the greatest number of criminal minds is also the most prolific. Birth control does not solve this problem, for even if the readily arguable point of whether the birth rate of the criminal is decreased by its practice be waived, it must be granted that the educated and therefore theoretically un-criminal class is the one most affected. The only possible solution seems to lie in prompt sterilization of criminals. If at the same time, those whose natural endowments fit them for parenthood are encouraged to produce, the trend will swing from the Jukes family on one side of the scale to the Adams family on the other.

VOLUME XIV

THE Managing Board of Volume XIV, which begins its labors with the next issue, will be announced at the Combined Publications Dinner to be held next week. The outgoing Managing Board extends its congratulations to the new Board, and its best wishes for the success of Volume XIV.

OUTLOOK

(*Continued from page 143*)

"I suppose the thing that carries most weight in my case is the general impression the man himself makes, which, in a general way, depends on personality in its broadest sense. Probably the thing of first importance is whether or not I like the man. Second, what degree of enthusiasm his system contains, and third, what his record has been. If he did not pass on either of the first two points, 100 per cent in the third qualification would not qualify him. On the other hand, if his record was poor, a superlative degree of qualification in the other two would not be sufficient.

As to record, I suppose the most impressive thing to me is whether or not he is a man who accomplishes things. The man who impresses me most on this line is the man who has partially or wholly worked his way through college and in addition has done well in his studies. If, besides this, he has participated successfully in extra-curricular work, that is still more impressing. In other words, that gives a picture of a man who really knows how to handle himself and his time.

If a man has but partially worked his way through college, he is apt to know something about the seamy side of business. He is more apt to realize, at the time some other company tries to inveigle him away, that there are probably 'thorns on the other rosebush.' He is more apt to be patient in his hurry to get along and therefore will probably stick it out."

Mr. Owen D. Young, in a recent address to the graduating class of St. Lawrence University, suggested that the seniors, having passed their college examinations, subject themselves to another examination, which might prove to be the most vital and important one of all. He said: "Perhaps you can afford to fool others about yourself, but you can not afford to fool yourself about yourself." In this examination he suggested the use of the following five questions:

"First. Have you enlarged your knowledge of obligations and increased your capacity to perform them?

"Second. Have you developed your intuitions and made more sensitive your emotions?

"Third. Have you discovered your mental aptitude?

"Fourth. Have you learned enough about the machinery of society and its history to enable you to apply your gifts effectively?

"Fifth. Have you acquired adequate skill in communication with others?"

He cautioned:

"Be on the guard always against letting yourself drift into occupations for which you are not fitted. You must discover your own aptitudes, you must pilot your own ship. If you fail to plot your course, or, knowing it, carelessly take your hand off the wheel, you will merely drift at the peril of the waves, and one day you will be wrecked and cast ashore. Do not neglect this discovery of your aptitude, and, finding it, do not fail to meet the sacrifices which may be necessary in the beginning to enable you to put it to effective use."

Quite often the question is asked: In view of the present scarcity of positions open for technically trained men, has my training at Massachusetts Institute of Technology, involving no small expenditure of time and money, been worthwhile?

At the last annual meeting of the Alumni Association, President Compton, speaking on this question, said:

"It is certainly true that in this as in every other field of life competition is becoming more and more severe. In the early pioneer days there was, comparatively speaking, no such thing as competition. The entire country and all its resources lay open for the taking. To take advantage of the resources required initiative and hard work, but it involved relatively little competition. The same thing was true of industries such as the electrical and chemical industries in their infancy. The whole field lay open before them to be conquered. The same thing again was true of the opening of technological schools. The field of applied science was a virgin field. It had to be opened up by hard work and by education of the people to realize its potentialities, but there were many more opportunities than there were men to take advantage of them.

"It was inevitable as the country has become more thickly settled, as the natural resources have been more completely explored and exploited, and as the country has rapidly accepted scientific and engineering developments, that competition should increase in all lines. In Europe the competition for desirable positions among technically trained men is much more severe than in this country, which is still in its period of rapid development and expansion. Nevertheless, I think that we must inevitably face the fact that competition will become increasingly great so as to lead people to claim that there is an overproduction of men in the engineering profession, just as truly as in the agricultural or medical or any other profession.

"If, however, we take a look ahead and plan wisely for the future, I think we are forced to conclude that we are steadily and gradually approaching the time in which highly desirable positions will be available only to men of exceptional training and natural ability, whereas men of mediocre attainments will have to be content with humbler positions. I believe that it is this situation which has led to the rapid development of postgraduate training for engineers during the past decade."

From this viewpoint it is no doubt true that the graduate who has found his technical training difficult, has found it hard to maintain a keen interest in his course and in mastering the problems put before him, may well consider, after a careful self-analysis and comprehensive study of occupations, the wisdom of seeking employment of a less technical type, a vocation calling for less purely scientific ability.

In almost any line of business, examples can be found of men without college training who have risen to important posts. These have been men who have industriously pursued the work at hand, have profited by keen observation of everyday operations, not only of their immediate concern, but also those in any way related to their particular work, and who have diligently used leisure time for study on lines tending to make them more valuable to their employers.

There is always room at the top. Executives seek the man who is doing the job a little better than the boss expects. It is perhaps more important to have this in mind than to be too much concerned with the selection of some particular job.

The Massachusetts Institute of Technology graduate may feel confident that the breadth and practical character of his education, as well as the insistence on thorough training in basic subjects, fit him to undertake, with reasonable expectation of success, whatever task may present itself. Moreover, keeping mind and heart ever alert for advancement both in the work at hand and for an opening in his chosen field, will ultimately lead to placement in the particular work for which he is fitted.

In conclusion, it should be plain that the senior must do much to help himself if he is to obtain employ-

ment. Valuable suggestions may be found in the many books on vocational guidance, personality, and placement. Our Library has copies of a number of such books, as well as bibliographies which will give access to others. Special mention may be made of the following:

"How to Get a Job During a Depression."— W. C. Graham.

"Self Measurement."— William DeWitt Hyde, former President of Bowdoin College.

"The Engineer: His Work and His Education."— Robert L. Sackett, Dean of Engineering, Penn State College.

"The Young Man in Business."— Howard Lee Davis, Director of Technical Training, New York Telephone Company.

"Foundations for Human Engineering."— Charles R. Gow, Professor of Humanics, Massachusetts Institute of Technology.

"Problems in Human Engineering."— F. Alexander Magoun, Professor of Humanics, Massachusetts Institute of Technology.

"Vocational Self-Guidance."—Douglas Fryer, Ph.D.

"Student Development."— J. E. Walters, Personnel Director, Purdue University.

"The College Graduate's Value to Industry."— Gen. R. I. Rees, Assistant Vice-President, American Telephone and Telegraph Co.; Extension Bulletin of North Carolina University, May, 1931.

"The Personnel Bibliographical Index."— W. H. Cowley, Professor, Ohio State University.

Valuable information may be obtained from catalogues of the various technical societies and trade associations, publications of national and local chambers of commerce, the United States Department of Commerce, and other governmental bureaus. Special information regarding the size, organization, and financial standing of companies can be found in such volumes as Bradstreet's, Moody's, and Poor's Reports. In the various trade papers as well as the daily papers are reports of new companies, together with information regarding activities in different lines of business, all of which will suggest the most promising fields in which to prospect.

TECHNOCRACY

(*Continued from page 147*)

Despite increasing production, total employment in 1929 was the same as in 1887.

These are merely random selections from the material gathered by Technocracy, and their drift is clear: *human* labor (the principal standby of the classical economists and even of the "materialist" Karl Marx) is steadily decreasing in favor of physical energy as the main instrument for doing work. Technology and the machine, utilizing natural resources, have so enormously extended the range and capacity of the original human engine that, within barely more than a century the rate of energy consumption on this continent has increased from the primitive 2,000 kilogram calories per capita per day to more than 150,000 kg. calories. In 1840 the United States, with a population of approximately 17,000,000, was consuming extraneous energy to the amount of 75 trillion B.t.u. per annum; in 1929, although the population had increased only about eightfold, the extraneous energy consumed had been augmented (mostly since 1900), to the enormous total of 27,000 trillion B.t.u., in 1929 — 353 times that of 1840.

That is to say, immediately prior to the most calamitous depression in history every man, woman and child in one of the richest areas on the world's surface was the potential beneficiary of the unparalleled security, comfort and plenty represented by his or her share in the work of one billion installed horsepower: an amount which, if utilized to full load capacity, would yield an output equal to the human labor of more than five times the present total population of the globe. Actually this area, occupying one twelfth of the world's land surface and with 6.7 per cent of its population, does 50 per cent of the world's work, while our own industrial workers receive, per unit of production, a smaller physical return than the Chinese coolie.

In terms of money, the per capita income in the United States in 1932 is $400; in terms of *energy* the individual, by working 16 hours a week, could enjoy a physical wealth equivalent to the purchasing power of approximately 10 times the 1929 dollar.

Technocracy, viewing this spectacle, offers no panaceas and indulges in no propaganda. Functioning solely as a research body, interested primarily in what Clerk Maxwell would call "the particular go" of the social mechanism, it merely develops, from its rigorously quantitative analysis, certain inferences regarding the actual situation.

Chief among these is an unsparing criticism of the "Price System," by which is meant "any means of exchange, or energy flow control, founded on a commodity valuation." Established during the long period of history when individual needs and personal initiative were dominant factors in social life, the price system associates "wealth" with *human* labor, and with the mere possession of usable physical things — of which "money" is the most important. Subsequently, under pressure of ever-widening commercial activity, it refined the instruments of credit, investment and interest, absentee ownership and debt creation. Always, however, the unit of exchange — whether corn, cowrie shells, wampum, gold or paper — was a measure of *value*. This value was related to the purely subjective entities of desires, not to any quantitative factors in the operation of a social mechanism, which are becoming more and more dependent upon physical laws and their social application by technology. In consequence, the persistence of an individualist Economics, with its artificial commodity (gold) valuation of an energy flow has resulted, among other things, in the piling up of debt claims against the industrial equipment of the United States and its operation of more than two hundred *billion* dollars. An increasing percentage of this increasing amount represents payments still due on obsolescent equipment.

Technocracy calls attention to the fact that when *human* labor is being progressively supplanted by *physical* energy in the production of goods and services (as is peculiarly the case on this continent) a medium of exchange predicated upon human labor and utilizing units of value rather than of measurement is hopelessly inadequate. "Horsepower" is no more reducible to dollars than heat is to transient physiological conditions. Energy, in whatever form, is a function of motion, and can be measured only by quantitative units, and the total energy available within a given area for "degradation into use forms" is the sole basis for determining the "physical" — as opposed to "price system" — wealth of the individual.

By way of concluding this highly condensed and necessarily imperfect account of a very large subject, a few quotations from Mr. Scott's first signed statement on Technocracy in the December *Living Age* would be appropriate:

"Technocracy," writes Mr. Scott, "makes one basic postulate: that the phenomena involved in the func-

tional operation of a social mechanism are metrical. . . . Technocracy further states that, as all organic and inorganic mechanisms involved in the operation of the social macrocosm are energy-consuming devices, therefore the basic metrical factors are: the factor of energy conversion, or efficiency; and the rate of conversion of available energy of the mechanism as a functioning whole in a given area per time unit."

"Physical science has outdistanced present social institutions to such an extent that man, for the first time in history, finds himself occupying a position in which a complete utilization of his knowledge would assure the arrival of certainty in a continental social mechanism. Man, in his age-long struggle for leisure and the elimination of toil, is now at last confronted not only by the possibility but by the probability of this arrival."

"America stands now at the cross-roads, confronting the dilemma of alternatives. The progression of a modern industrial social mechanism is unidirectional and irreversible. Physically, this continental area has no choice but to proceed with the further elimination of toil through the substitution of energy for man hours. There can be no question of returning to premachine or pretechnological ways of life: a progression once started must continue. Retrogressive evolution does not exist."

INDUSTRY

(*Continued from page 150*)

The function of interpreting events and trends in the industry or profession is performed almost entirely by the editorial page of the paper. However, feature articles are also used to interpret events as also are interviews with important business men and industrialists who are known to think in a forward way about an industry's problem.

The third function — that of promotion of sound thought and policies — is carried out by all three of these classifications of reading matter — by the practical information mentioned, the news department, and the editorials.

In addition, however, to helping upon major problems, the business press must concern itself as well with detailed problems; for these, though each in itself may be small, become highly important because of their frequent repetition. Consequently, most business papers run a practical department. These departments are really dragnets for ideas that cut costs and time in the field and in the shop. Somewhat similar to the work of these departments, is the solving of the problems of individual readers who cannot find the information they want in either magazines or textbooks. These "question and answer" departments are conducted by a number of business papers.

The news of an industry is of vital importance to all engaged in it. For that reason good business papers have built up strong news departments which carry to the men of the industry week by week the story of what is going on. Here is found the real pulse of an industry or profession.

Closely akin to the function of reporting the news is that of reporting conventions. It is almost literally true that if a man cannot go to a convention, the appropriate business paper will bring the convention to him. Of somewhat similar order is that of keeping conventions informed about themselves — and to facilitate this purpose, many business papers publish daily convention newspapers at important association meetings throughout the country.

Since the Great War there has been a very keen interest in the statistics of industry, such as volume of production, stocks, shipments, financial factors. Business papers that are leaders in their respective fields have long been keenly aware of the importance of such statistics, and statistical data have been one of the characteristics of many such publications.

We are frequently asked why it is that business papers have such large editorial staffs. Popular magazines with a similar amount of reading material get along with two or three editors whose work is limited to passing upon and editing manuscripts submitted for publication. The reason for the large number of editors in our kind of publishing is that the business paper is written for specialists, and consequently must be written by specialists. Each paper must, therefore, have a sufficient number of editors that each can specialize on an important branch of the industry or profession and be able to speak as an authority.

Some people still think of any editor as a sort of literary philosopher who is shielded from the world in his sanctum sanctorum, armed with a quill pen, condescendingly passing down morsels of wisdom to a hungry world.

If this has been your picture of a business-paper editor, forget it. If there ever was such an editor in our field, he is either dead or out of a job. A real editor is a man of action. He should, it is true, be a scholar, and he must be an eternal student. But his big job is to keep in touch with the men in his industry, studying their accomplishments, absorbing their ideas, combining them with his own to make a real paper.

Ability to write well is an invaluable editorial asset. Yet, taken alone, it will never make an editor. Now and then a man comes looking for an editorial job. "I always got *A* on my compositions in English," he says, "and so I think I would make a good editor." It means as much as if I went to a hospital and said: "I have a winning way with kiddies — please put me in charge of the Children's Ward." No literary skill will get the business-paper editor by if he has nothing worth saying to those practical men in industry and in engineering who look to his paper for expert assistance in earning their daily bread and butter.

The industrial editor feels himself only incidentally a journalist. He is in the publishing industry, to be sure,

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but he is even more an integral part of the industry represented by his readers.

Did you ever stop to think that the editor is a manufacturer? He manufactures a paper. The automobile maker thinks he is doing well when he changes a few parts every year and calls it a new model. The editor, on the other hand, must design and build each week or month a model new in every part from radiator cap to tail light, and each model must be a good one. Obviously, the editor must be versatile. It is no job for the mere routine worker.

This task of the business paper, of creating greater intelligence in business and in industry, is part of the general function of moulding industrial and engineering opinion. Industry, without the business press, is inarticulate. Through the business press it becomes articulate. Nothing can be done — whether in the life of an individual, of a corporation, of an industry, or even of the nation itself — unless there be first an idea. For great movements, an idea must be accepted by many minds. The business press is an agency for putting such ideas in the minds of a whole industry and thus helping to form industrial opinion precedent to action.

I have endeavored to give you an idea of the services of the business press, and of the editors behind the paper. It must be apparent that the constant emphasis upon plant modernization, on standardization of products, on the economics of labor-saving machinery and devices, conceived for the benefit of the reader, at the same time creates and stimulates markets for the manufacturer. But more important than these stimuli which create specific demands is the great educational influence, working week by week and month by month for the creation of higher intelligence in industry, business and the professions, and thus building an alert, responsive and progressive industrial group. It is to the service of progressive men that the business paper is dedicated. It has no part with the unambitious. Its mission is to those who strive to attain new standards in quality, in quantity of output, and in economy of time and labor.

ENGINEERING DIGEST

(*Continued from page 155*)

WATER LIMITATION AT NIAGARA FALLS

W. K. Bradbury
The Military Engineer

NIAGARA FALLS may presently undergo a bloodletting for the sake of its health. More correctly, the diversion for use in waterpower of a large part of the Niagara River — possibly as much as one-half — from the famous cataract is being seriously considered, not purely as a commercial proposition, but as a means of preserving the beauty of the falls.

The Niagara Falls Power Company has constructed an accurate model of the upper rapids and Grass Island pool, the falls, and Maid of the Mist pool. The model is constructed of concrete and stone to a horizontal scale of 1 to 100 and a vertical scale of 1 to 25. Careful computations determined the proper amount of water to be passed over the model to make it a working laboratory for study of the Niagara and its problems.

Experiments with the model showed plainly that with a reduced flow on the cataracts, but with proper distribution of the stream flow, the scenic spectacle of the falls could be enlarged and made permanent. Indeed it became evident that regardless of the amount of diversion for power purposes, the river must be regu-

Sectional view, Fig. 106, Jenkins Standard Bronze Globe Valve, screwed.

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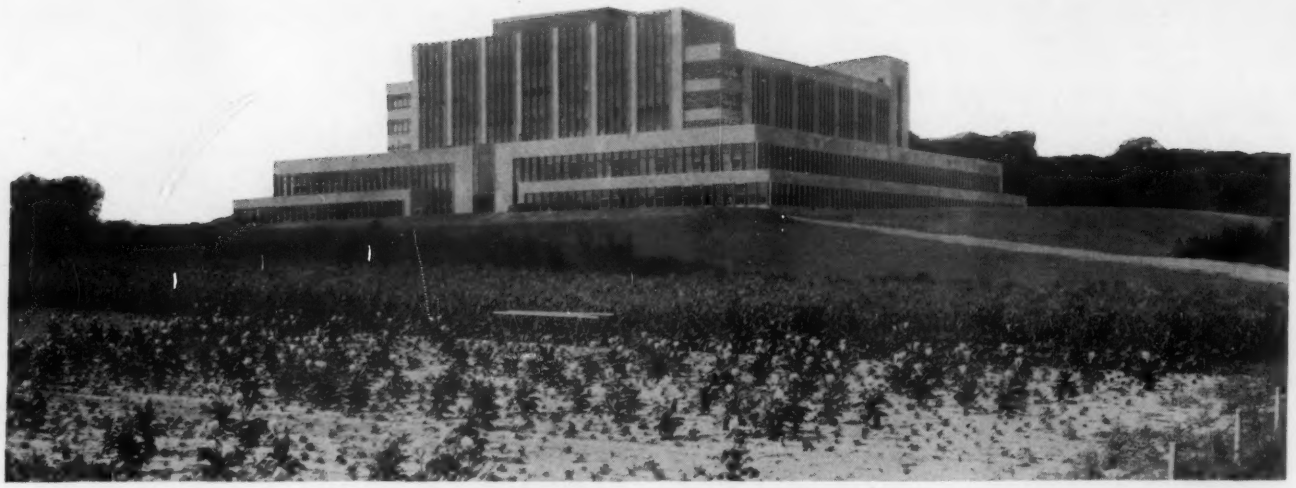

FOREST PRODUCTS LABORATORY *Mechanical Engineering*

What temperature is necessary to sterilize wood so that all fungi within it are killed? What effect does steaming lumber have on its subsequent durability? How can the ravages of the white ants be prevented in woodwork located in warm climates? What is the smallest sized tree that it pays to cut? Those working in the New Forest Products Laboratory in Madison, Wisconsin, are seeking the answers of these and many other queries pertaining to the lumber industry.

lated in order to prevent the cutting back of the central notch in the Horseshoe Falls. Since 1764 this notch has gone upstream an average of 5 feet a year, a total of over 900 feet. In so doing, the notch has robbed the shores of water because the river bed is about 10 feet ower in the central channel than it is along the shores. The character of the rock at the falls is such that surface abrasion is negligible; the undermining of softer strata below the cliff by the force of the great volume of water washing against them below is the cause of the rapid recession.

A new treaty between Canada and the United States, promulgated in 1929 and based largely upon the results of these experiments, calls for three main projects to protect the falls:

1. A submerged weir upstream off the Canadian shore to assure adequate flow in the American channel and between the Three Sister Islands.

2. Excavations along the shores of Goat Island and Table Rock, to lower the river bed enough so that water will flow over that part of the cliff which has in late years become bare.

3. Submerged weirs placed so that a portion of the deep central channel will be deflected toward the sides in order to check erosion in the notch.

With the scenic spectacle thus assured, the treaty proposes an experimental extra diversion of water, to be carried on for not more than seven years and in the winter months only. It may then be observed whether the scenery suffers by such increased diversion.

VARIABLE PROPELLER

Aero Digest, *November, 1932*

WHAT the gear-shift does for the automobile, a device known as the "Smith controllable-pitch propeller" bids fair to do for the airplane. This kind of propeller was used on the Wedell-Williams and Gee Bee planes on their record-breaking flights at the Cleveland air races last year. Its pitch is controlled by the pilot in the cockpit and can be changed only while the engine is running, because the motive power is supplied by the rotating shaft of the engine. To effect an increase in pitch the pilot pushes the control handle forward to its limit of travel (about one inch) and holds it there while a system of worm gears causes the angle of the blades with the perpendicular to increase one degree every two seconds when the engine is rotating at 1700 r.p.m. The blades will continue to twist as long as the control is held in this position, up to the limit of the automatic stop. When the pilot desires to decrease the pitch of his propeller he pulls the control lever back to its other extreme and waits until the new, smaller angle has been attained.

COLORADO AQUEDUCT

General Electric Review, *November, 1932*

FOR only a short time will the Hoover Dam remain an uneclipsed engineering project from the point of view of the amount of labor necessary for its construction. Plans have already been formulated and sanctioned for the building of a 250-mile Colorado River Aqueduct which will satisfy Southern California's rapidly increasing demand for water. In contrast with the steady down-hill slope of the ancient Roman aqueducts, the mains of this proposed system will cross a mountain range as they bear a man-made stream from a point on the Colorado River 140 miles below the site of the Hoover Dam to a terminal reservoir near the Pacific Coast.

In order to accomplish this feat, the water will have to be pumped in five separate stages with heads varying from 137 to 460 feet in height, requiring an expenditure of 371,000 horsepower. This energy will be brought over 220,000 volt transmission lines from the then operating generators of the Hoover Dam. The system will contain 25 tunnels totalling 84.9 miles in length, 75 miles of lined canals, 54.6 miles of covered conduits, and 24.5 miles of pressure lines and siphons.

Here are a few rough comparisons of the proposed Colorado River Aqueduct with the Hoover Dam. The Aqueduct will use 14 per cent more concrete, will excavate 38 million cubic yards of earth as compared to the 6 million of the Hoover Dam, will use about three times as much steel, will need 250 million kilowatt hours of electricity in contrast with the 120 million used on the other project, will cost nearly twice as much, and will use from 10 to 14 thousand men instead of the three to five thousand employed in the construction of the Hoover Dam.

THE TECH ENGINEERING NEWS

Volume XIII

INDEX

February 1932—January 1933

Subject and Author	*Month*	*Page*
A		
Accounting — A Promising Field for Engineers William I. McNeill '17	Mar.	27
Ashdown, Avery A. Culmination of the Development of Chemical Research at Technology	Dec.	130
B		
Bennett, Ralph D. Prospecting for the Cosmic Ray	May	73
Bennett, Ralph D. Vitalized Education The Experimental Side	Dec.	127
Bowles, Edward L. Vitalized Education The Human Side	Dec.	126
Brady, C. T. Opportunities in the Argentine?	Feb.	5
Burgess, Dr. George K. Engineering at the United States Bureau of Standards	May	65
Burns, Gordon Kendrick Rearranging the Connecticut River	Apr.	51
C		
Campbell, Harris S. The Design Features of the Autogiro	Oct.	89
Church, Leonard H. Helping Industry to Build Itself	Jan.	150
Compton, Dr. Karl Taylor Three Adventures in Physics	Oct.	85
Culmination of the Development of Chemical Research at Technology Avery A. Ashdown	Dec.	130
Cushing, Charles Phelps Photographs and Description of Manhattan's Skyline	Mar.	28
D		
Design Features of the Autogiro, The Harris S. Campbell	Oct.	89
Development of Rigorous Thinking, The Prof. Richard Henry Frazier	Nov.	105
Dudley, Beverly Standards for the Radio	Nov.	115
E		
Earth and Its Creatures, The Part I. From Sun to Cell	Mar.	25
Part II. Whence Came the Moon? The First Seas?	Apr.	48
Part III. Conclusion: Life Comes to the Earth Frederick K. Morris	May	70
Earthquakes Ernest A. Hodgson	Nov.	109
Economics Applied to Engineering Edwin R. A. Seligman	Dec.	125
Electronics and the Engineer Wayne B. Nottingham	May	72
Engineering at the United States Bureau of Standards Dr. George K. Burgess	May	65
Engineering Education — Its Relation to a Successful Career R. I. Rees	Feb.	8
Engineering the Low-priced V-Eight Engine Donald Glen Fink	Apr.	46
Engineer's Place in Railroading, The Norman Litchfield	Apr.	50
F		
Fink, Donald Glen Engineering the Low-priced V-Eight Engine	Apr.	46
Foss, Carl E. The Manufacture of Printing Ink and Its Characteristics	Jan.	151
Fossett, Richard L. The Prophet's Word	Nov.	103
Frazier, Prof. Richard Henry The Development of Rigorous Thinking.	Nov.	105
G		
Garcia, John A. Strip Coal Mining	Feb.	9
Geometry of the Fourth Dimension, The Charles S. Sutton	Feb.	6
Gray, Dr. Truman S. A Laboratory for Practical Electronics	Jan.	144
Guillemin, Ernst A. What's Wrong with Engineering Education?	Mar.	30
H		
Helping Industry to Build Itself Leonard H. Church.	Jan.	150
Hodgson, Ernest A. Earthquakes	Nov.	109
I		
Industrial Relations, The Engineering Executive in Samuel Lewisohn	May	67
L		
Laboratory for Practical Electronics, A Dr. Truman S. Gray	Jan.	144
Lewisohn, Samuel The Engineering Executive in Industrial Relations	May	67
Lewisohn, Samuel New Ideas on an Old Engineering Problem	Oct.	90
Litchfield, Norman The Engineer's Place in Railroading	Apr.	50

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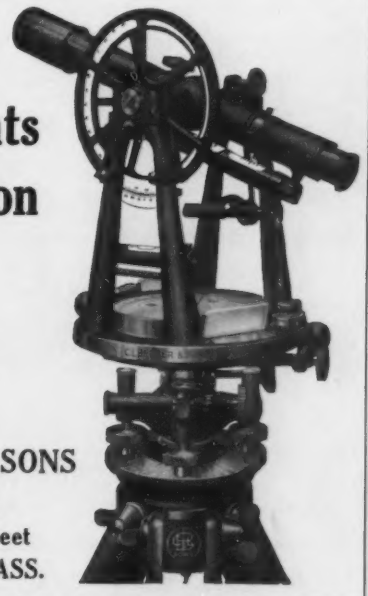

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Subject and Author	*Month*	*Page*
Locke, Frank L.		
The Outlook for the 1933 Senior	Jan.	143
Loengard, Richard O.		
The Science of Chromium Plating	Dec.	128
Lucas, Edmond Delong		
The Meaning of Modernism in Architecture	May	68
M		
Magoun, F. Alexander		
The Problem of Understanding Ourselves	Apr.	45
Manhattan's Skyline, Photographs and Description of		
Charles Phelps Cushing	Mar.	28
Mann, Cecil E.		
Rocket Travel — A Transportation Problem	Oct.	87
Manufacture of Printing Ink and Its Characteristics, The		
Carl E. Foss	Jan.	151
McNeill, William I. '17		
Accounting — A Promising Field for Engineers	Mar.	27
Meaning of Modernism in Architecture, The		
Edmond Delong Lucas	May	68
Menzel, Dr. Donald H.		
The Sun — An Engineering Masterpiece	Jan.	148
Moore, Frank H., Jr.		
Steam on the Road	Nov.	108
Morris, Frederick K.		
The Earth and Its Creatures		
Part I. From Sun to Cell	Mar.	25
Part II. Whence Came the Moon? The First Seas?	Apr.	48
Part III. Conclusion: Life Comes to the Earth	May	70
Muhlfeld, John E.		
Steam on the Road	Nov.	108
N		
New Ideas on an Old Engineering Problem		
Samuel Lewisohn	Oct.	90
Nottingham, Wayne B.		
Electronics and the Engineer	May	72
O		
Oil and the Tech Man		
W. B. Ross	Nov.	106
Opportunities in the Argentine?		
C. T. Brady	Feb.	5
Outlook for the 1933 Senior, The		
Frank L. Locke	Jan.	143
P		
Problem of Understanding Ourselves, The		
F. Alexander Magoun	Apr.	45
Prophet's Word, The		
Richard L. Fossett	Nov.	103
Prospecting for the Cosmic Ray		
Ralph D. Bennett	May	73
R		
Rearranging the Connecticut River		
Gordon Kendrick Burns	Apr.	51
Rees, R. I.		
Engineering Education — Its Relation to a Successful Career	Feb.	8
Rocket Travel — A Transportation Problem		
Cecil E. Mann	Oct.	87
Ross, W. B.		
Oil and the Tech Man	Nov.	106
Ruff, Alonzo W.		
The Manufacture of Solid Carbon Dioxide	Oct.	88
S		
Science of Chromium Plating, The		
Richard O. Loengard	Dec.	128
Seligman, R. A. Edwin		
Economics Applied to Engineering	Dec.	125
Society, A Problem in Thermodynamics		
Harold Ward	Jan.	146
Solid Carbon Dioxide, The Manufacture of		
Alonzo W. Ruff	Oct.	88
Standards for the Radio		
Beverly Dudley	Nov.	115
Steam on the Road		
Frank H. Moore, Jr. and John E. Muhlfeld	Nov.	108
Strip Coal Mining		
John A. Garcia	Feb.	9
Sun, The — An Engineering Masterpiece		
Dr. Donald H. Menzel	Jan.	148
Sutton, Charles S.		
The Geometry of the Fourth Dimension	Feb.	6
T		
Three Adventures in Physics		
Dr. Karl Taylor Compton	Oct.	85
V		
Vitalized Education		
The Experimental Side		
Ralph D. Bennett	Dec.	127
The Human Side		
Edward L. Bowles	Dec.	126
W		
Ward, Harold		
Society, A Problem in Thermodynamics	Jan.	146
Warner, William L.		
Welding for Modern Structures	Feb.	10
Welding for Modern Structures		
William L. Warner	Feb.	10
What's Wrong with Engineering Education?		
A Suggested Program for Classroom Lectures		
Ernst A. Guillemin	Mar.	30
The Student Point of View		
Beaumont Whitton '33	Mar.	31
Whitton, Beaumont '33		
What's Wrong with Engineering Education?	Mar.	31

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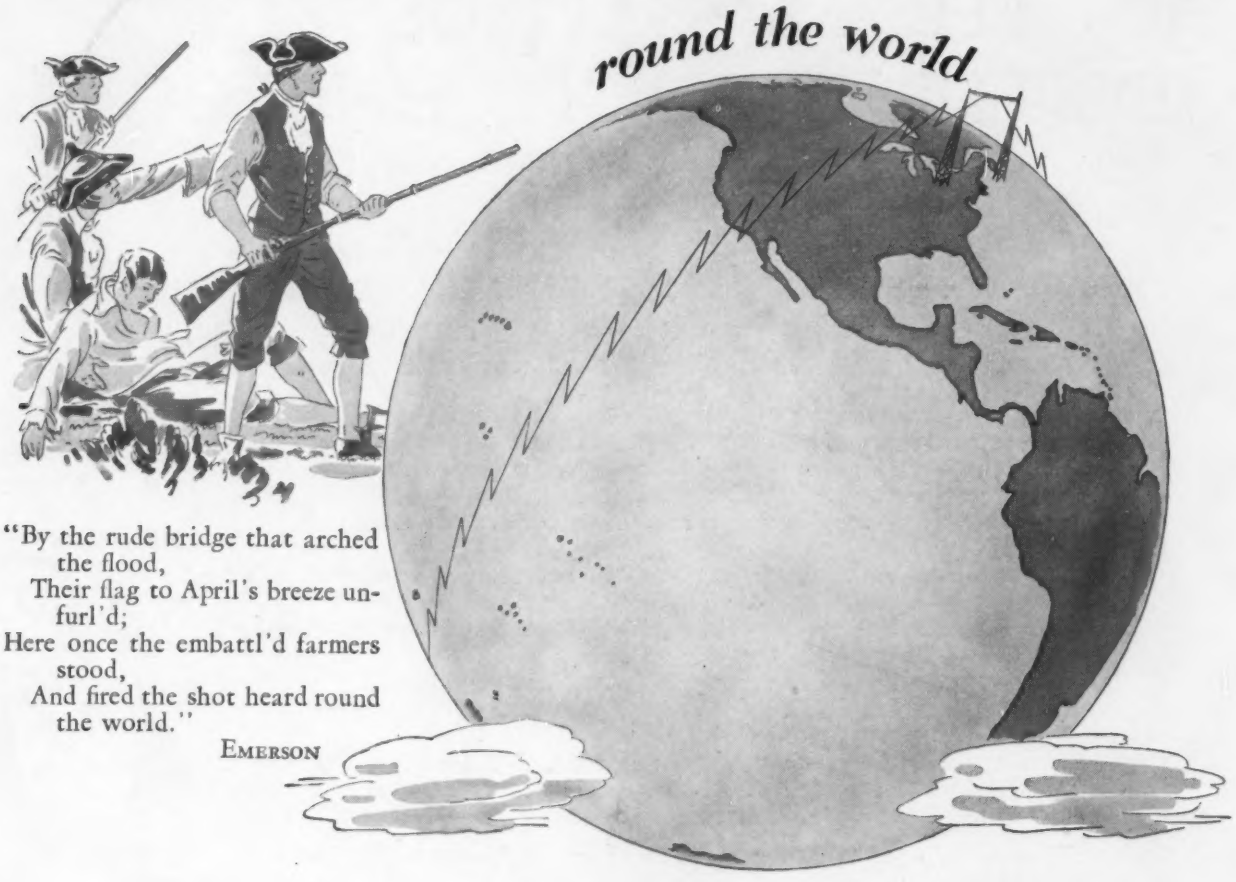
The shot ACTUALLY *heard round the world*



"By the rude bridge that arched the flood,
Their flag to April's breeze unfurl'd;
Here once the embattl'd farmers stood,
And fired the shot heard round the world."

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